Permabond®
Engineering Adhesives

Selection Guide for Engineers

From design to process - An indispensable resource for all engineers.

PERMABOND Adhesives & Sealants for Manufacturing, Assembly and Repair.

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Adhesive Selection

Selecting the most appropriate adhesive for an engineering application requires consideration of a number of factors:

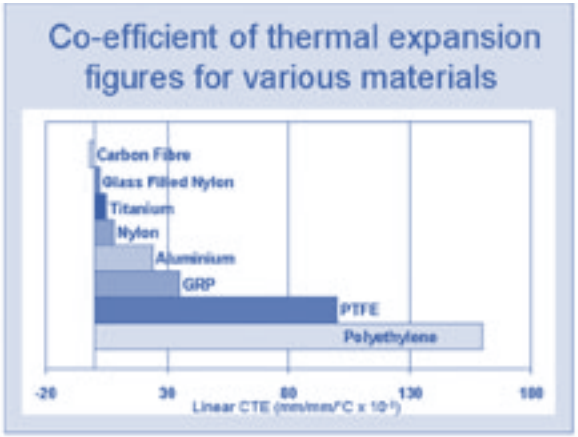
Surfaces:

- Can the substrate(s) be bonded?
- Which adhesive works best on the substrate?
- Surface preparation requirements
- Reactivity of the substrate affects adhesive cure-speed.

Table below shows how anaerobic adhesive cure is affected by surface reactivity:

Super Active (Very fast cure)	**Active (Fast cure)**	**Inactive (Slow cure)**	**Passive (Activator Required)**
Brass Copper Magnesium	Steel Nickel Iron Aluminium	Anodized aluminium Cadmium finishes Chrome finishes Passivated metals Stainless steel Titanium Zinc	Ceramics Glass Plastics Painted finishes Lacquered finishes

Bonding dissimilar materials together requires special consideration, particularly in an environment subject to temperature change. This is because differential thermal expansion and contraction between materials can induce stress into the substrates and into the joint. For this reason slightly flexible, toughened adhesives can be better than rigid methods of fixture - such as mechanical fastenings.



Joint Design (see also next section):

There are three basic joint types; coaxial, lap and butt joints. Anaerobic adhesives are usually most suitable for coaxial type joints (where one part slots into another). Whether or not the joint needs to be dissembled will determine the strength of adhesive to use. Lap joints can be bonded easily with cyanoacrylates.
For butt joints (not usually suitable for adhesives) or other joints which could be subject to particularly heavy loading or peel and cleavage stresses, toughened epoxies and structural acrylic adhesives offer the best performance.

Gap fill and adhesive viscosity:

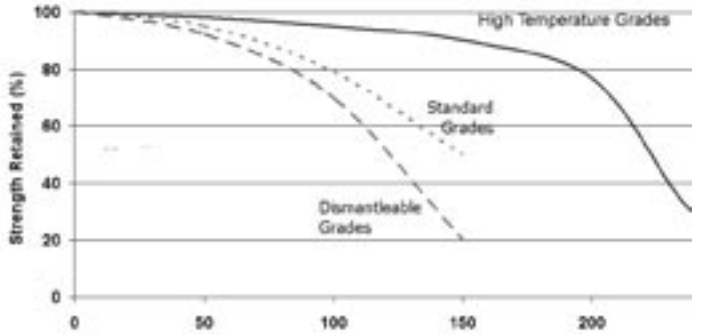
Viscosity of adhesive and gap fill capability are closely related, the higher the adhesive viscosity, the larger the gap filling capability. To help "get a feel" for viscosity measurements, the list below shows everyday substances and their approximate viscosity.

Substance	Viscosity (mPa.s)	Substance	Viscosity (mPa.s)
Water	1	Maple syrup	5,000
Milk	3	Honey	10,000
SAE 10 Motor oil	85-140	Choc. syrup	25,000
SAE 20 Motor oil	140-420	Ketchup	50,000
SAE 30 Motor oil	420-650	Mustard	70,000
SAE 40 Motor oil	650-900	Sour cream	100,000
Castor oil	1,000	Peanut butter	250,000

Service conditions:

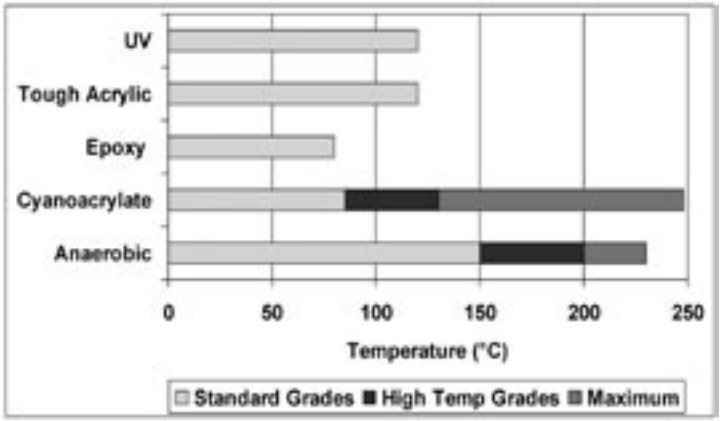
Chemical exposure can affect adhesives (a detailed compatibility table is provided in this booklet). It is important to consider not only the type of chemical the adhesive will be exposed to, but the concentration and the temperature of that chemical, the loading of the joint and whether the joint design leaves adhesive vulnerable to attack.

The temperature range the joint will be exposed to is an important factor in deciding which adhesive to use. Adhesive strength reduces as temperature increases, as demonstrated in the graph to the right. Provided adhesives are kept within their recommended temperature range, full strength should be regained upon returning to room temperature.



Above: Graph showing how temperature affects strength retention of Permabond anaerobic adhesives.

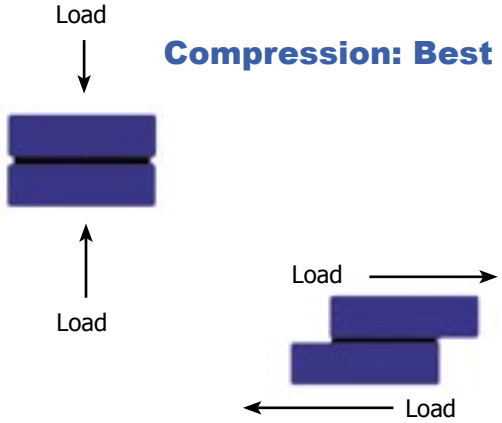
Below: Table showing the typical temperature performance of different adhesive chemistries.



Joint Design

It is vital to consider joint configuration in the early stages of your product design to achieve maximum performance. Joints that have originally been designed to be welded may need to be redesigned obtain optimum performance with adhesives. The engineer also needs to consider the loading of these joints and where the forces occur. The diagrams on these two pages explain which joints are good, which to avoid, and some suggested alternative joint designs.

These are examples of good adhesive joint design.



Compression: Best

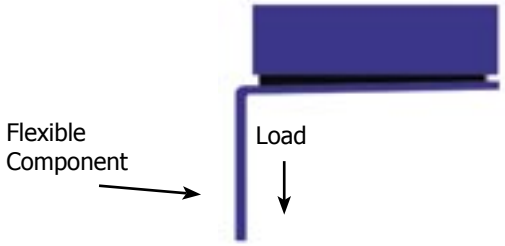
Shear: Good

These are examples of bad adhesive joint design.

Cleavage: Bad

Load

Peel: Bad



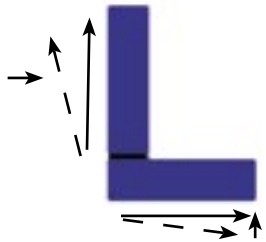
Handy Tip: If joint design cannot be modified, opt to use a toughened adhesive with high peel-strength.

Straight Butt-Joint: Bad

Problems occur because this type of joint is not very stable; a slightly off-centre force will cause a crack to propagate through the joint.

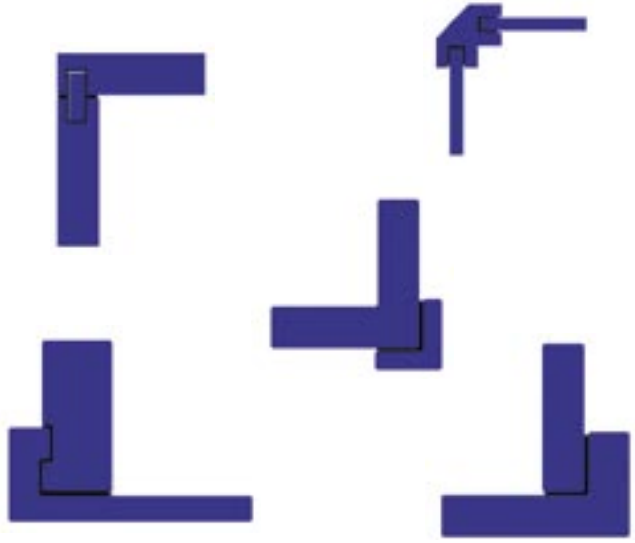
Suggested Alternatives

Corner Butt-Joint: Bad



A similar problem can occur with a corner joint, if an indirect force is applied, it can result in the introduction of a cleavage force into the joint.

Suggested Alternatives



Surface Preparation

Most materials can be bonded without surface pre-treatment unless surfaces are grossly contaminated. To achieve maximum performance and repeatable results, it is advisable to carry out a certain level of surface preparation or use a particular adhesive. Bold text in table= preferred choice.

Permabond QFS16: This activator is for use with Permabond cyanoacrylates to accelerate cure rate, particularly on less active surfaces or where adhesive requires curing on the outside of a joint.
Permabond Polyolefin Primer (POP): Essential for priming hard to bond surfaces such as polypropylene, polyethylene, silicone and PTFE. Bond with Permabond cyanoacrylate adhesive.

Metal	Preparation	Anaerobic	Cyano	UV	Epoxy	Structural Acrylic
Aluminium	Abrade and degrease. Alternatively acid etch with dichromate. Aluminium has a weak oxide layer which is best removed to achieve a high-strength bond.	**Yes**	Yes	Yes*	**Yes**	**Yes**
Brass	Abrade and degrease. Alternatively etch with ammonium persulphate (contact Permabond for further details).	**Yes**	Yes	Yes*	**Yes**	**Yes**
Cast Iron	Abrade and degrease. Remove all surface contamination, rust and loose particles.	**Yes**	Yes	Yes*	**Yes**	**Yes**
Copper	Abrade and degrease. Alternatively etch with ammonium persulphate (contact Permabond for further details).	**Yes**	Yes	Yes*	**Yes**	**Yes**
Mild Steel	Abrade and degrease.	**Yes**	Yes	Yes*	**Yes**	**Yes**
Stainless Steel	Abrade and degrease. Alternatively etch with dichromate. No surface preparation may lead to a weak bond.	**Yes**	Yes	Yes*	**Yes**	**Yes**
Zinc	Degrease. If possible, etch with hydrochloric acid (contact Permabond for further details).	**Yes**	Yes	Yes*	**Yes**	**Yes**
Zintec	Degrease. Toughened, slightly flexible adhesives tend to work best on this surface.	Yes	Yes	Yes*	Yes	**Yes TA435 best**

Methods:

Abrade and degrease: Abrade with Scotchbrite®, wire wool or carborundum (sand) paper. Alternatively grit blast. Degrease with a solvent such as acetone or isopropanol (which is particularly suited to more sensitive plastic materials).
Permabond ASC10: This is a surface activator for anaerobic adhesives, suitable for use on non-metallic surfaces or on less active metals to accelerate cure speed.

*UV curable adhesives can be used on most surfaces, although one substrate must be clear to allow UV light through to cure the adhesive.

For reactivity of metals (which affect anaerobic adhesive cure speed) see table in section 1, 'Adhesive Selection'. This will determine whether ASC10 should be used to attain desired cure speed.

Plastics, rubbers and other non-metallic materials

Plastic/Rubber	Preparation	Anaerobic	Cyano-acrylate	UV	Epoxy	Structural Acrylic
ABS	Can be bonded as received.	Yes (Use ASC10 first)	**Yes**	Yes*	Yes	**Yes**
Acetal	Abrasion can help. Prime with Permabond POP primer if bonding with cyanoacrylates.	Yes (Use ASC10 first)	**Yes**	No	No	No
Acrylic	Can be lightly abraded.	Yes (Use ASC10 first)	**Yes**	Yes*	Yes	Yes
EPDM	Bond as received.	No	**Use 105**	No	No	No
HDPE / LDPE / Polypropylene	Prime with Permabond POP primer and bond with cyanoacrylates. For other adhesives surface treat via flame, corona or plasma treatment equipment.	Flame treat & ASC10 first	Yes	Yes*	**Yes**	**Yes**
Nitrile Rubber	Bond as received.	No	Yes	No	No	No
Nylon® (polyamide)	Dry out at 60°C for several hours or overnight. Abrade surface. Can be difficult to bond if unfilled.	Yes (Use ASC10 first)	Yes	Yes*	Yes	Yes
PVC	Bond as received	No	**Yes**	No	No	No
Silicone	Prime with Permabond POP primer and bond with cyanoacrylates	No	**Use 105**	No	No	No

Handy tip: Check a discreet area of plastic for compatibility with adhesives / cleaners as some are prone to stress cracking.

Material	Preparation	Anaerobic	Cyano-acrylate	UV	Epoxy	Structural Acrylic
Carbon Fibre	Light abrasion and degrease.	No	Yes	No	**Yes**	**Yes**
Ceramic	Degrease. Remove glaze by abrasion.	Yes (Use ASC10 first)	Durability could be poor	Yes*	**Yes**	**Yes**
Ferrite	Degrease with solvent.	Yes (Use ASC10 first)	Yes	Yes*	**Yes**	**Yes**
Glass	Degrease with solvent.	No	Durability will be poor	**Yes**	Yes	Yes
GRP	Abrade and degrease.	No	No	No	**Yes**	**Yes**

*One substrate should be clear for UV light to pass through.

Chemical Compatibility & Anaerobic Adhesives

Few industrial chemicals have a damaging effect on Permabond's anaerobic adhesives. However, acids / alkalis or polar solvents in high concentrations (or if hot) could have some effect. Call 800-640-7599 for items not listed.

Code:

A: Most Permabond products are suitable
B: For concentrations up to 10% most adhesives can be used
C: Only use high-strength Permabond products
X: Not suitable for Permabond anaerobic adhesives.

Liquids:

Acetic acid	B
Acetone	A
Alcohols	A
Ammonia sol.	C
Animal fat	A
Battery acid	B
Bleach	A
Bromine	X
Carbolic acid	B
Carbonic acid	B
Cement	A
China Clay	A
Chromic acid	C
Citric acid	C
Copper sulfate	A

Creosote	A
Cyanide sol.	B
Detergents	A
Dielectric fluid*	A
Dye stuffs	A
Ethyl acetate	A
Ferric chloride	B
Fertilizer*	A
Formaldehyde	C
Glycerine	A
Gypsum	A
Hexane	A
Hydrochloric acid	C
Ink	A
Insecticide*	A

Isocyanate resin	A
Jet fuel	A
Kerosene	A
Lactic acid	A
Nitric acid	X
Oil (fuel)	A
Oil (hydraulic)	A
Oil (linseed)	A
Oil (lubricating)	A
Oil (mineral)	A
Ozone (wet)	X
Paraffin	A
Perfume	A
Petrol	A
Petroleum jelly	A
Photo developer*	A
Phosphoric acid	C
Sewage	A
Shellac	A
Sodium hydroxide	C
Starch	A
Sugar	A

Sulphuric acid	C
Sulfurous acid	C
Toluene	A
Trichloroethane	A
Turpentine	A
Water (fresh/sea)	A
Water (heavy)	A
Xylene	A

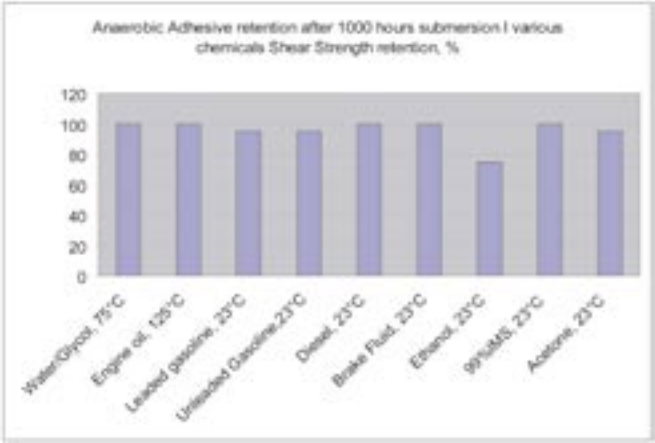
*Test first as some brands/types are more aggressive than others.

Gases

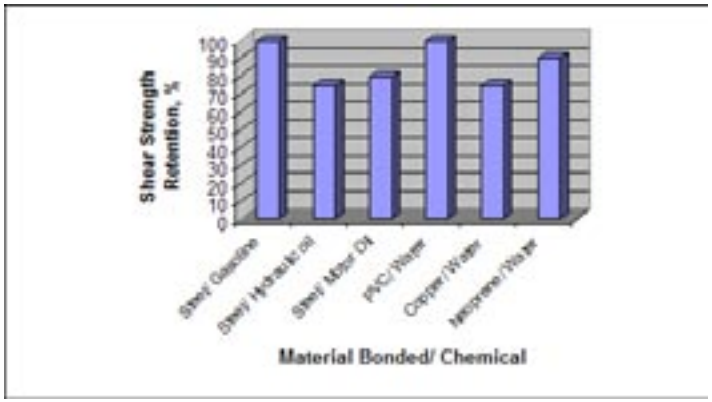
Air	A
Carbon mon/dioxide	A
Chlorine	X
Freon	C
Helium	A
Methane	A
Natural gas	A
Pure oxygen	MH052
Ozone	X
Propane	A
Steam	X

Chemical Durability

Graph showing anaerobic adhesive strength retention (after 1000 hours submersion in various chemicals).



Graph showing cyanoacrylate adhesive strength retention (after 14 days immersion in various chemicals.



Chemical Compatibility

Introducing Adhesives to a Production Line

Key considerations when introducing adhesives into a production line include:

- Preparation of substrates
- Dispensing method
- Automation
- Clamping / jigging
- Cure speed
- Curing equipment

Below: Production throughput planner (based on 100% efficiency).

1 piece every...	Pieces per minute	Pieces per hour	Pieces per day (8 hours)	Pieces per week (40 hours)	Pieces per month (21 days)	Pieces per year (50 weeks)
0.5 seconds	120	7,200	57,600	288,000	1,209,600	14,400,000
1 second	60	3,600	28,800	144,000	604,800	7,200,000
5 seconds	12	720	5,760	28,800	120,960	1,440,000
10 seconds	6	360	2,880	14,400	60,480	720,000
30 seconds	2	120	960	4,800	20,160	240,000
1 minute	1	60	480	2,400	10,080	120,000
5 minutes	-	12	96	480	2,016	24,000
10 minutes	-	6	48	240	1,008	12,000
30 minutes	-	2	16	80	336	4,000
1 hour	-	1	8	40	168	2,000

Substrate preparation on a high-speed production line

It is helpful to receive substrate components in a consistent condition with little variation in surface finish. We would recommend checking this regularly as sometimes component suppliers switch materials, cutting oils or release agents which could necessitate changes in surface preparation technique.
For large batch production components can be degreased via large-scale jet washes on a conveyor system. It is important such systems are not overloaded and that parts can drain off to give a consistently clean/dry surface afterwards.

Grit blasters offer a quick and easy way to abrade metal surfaces to remove oxide layers. It is important to change grit regularly to keep it sharp and free from contamination.

Surface activators, such as the Permabond QFS16 (for cyanoacrylates) and ASC10 (for anaerobics) are available in bulk for batch dipping of components. This helps to ensure a clean, reactive surface for the corresponding adhesive to bond to.

Dispensing methods

For a rapid production line, high-speed dispensing systems can easily be introduced. These can range from semi-automatic e.g. a system which delivers a metered dose to the component after a person triggers the dispensing valve via foot pedal, to fully automatic where minimal human intervention is required. Permabond offer adhesive products in bulk packaging to fit most dispensing equipment around the world.
Two-part adhesives require more consideration to ensure the metered dose of resin and hardener is correct and that mixing is adequate. Upon installation the equipment must be properly calibrated to ensure the correct mix ratio of adhesive is being dispensed.

Automation

For high-speed production lines, conveyors, robotics and X-Y machines can greatly aid increased production rates. Adhesives can easily be incorporated into highly automated systems with minimal cost.

Clamping / jigging & cure speed

It is important bonded parts are not disturbed during the curing process, at least until they have reached handling strength. Otherwise components could end up wrongly aligned or could result in a lower bond strength. To keep clamping time to a minimum, choose one of Permabond's rapid curing adhesives to speed up production rates.

- UV-curables - cure in 1-2 seconds on exposure to high-intensity UV-light
- Cyanoacrylates - cure to handling strength in 5 - 30 seconds
- Structural acrylics - quick curing grades reach handling strength in 1-4 minutes
- Anaerobics - range from two minutes up 1 hour depending on substrates
- Two-part epoxies - can range from 5 minutes to several hours depending on grade

Curing Equipment

UV-curable adhesives need to be cured with a UV lamp. High-powered spot lamps or high-intensity flood lamps are ideal for high-speed production lines. Low-powered flood lamps can be used on smaller production lines or on larger assemblies, these are a low-cost option but cure times need to be adjusted.

Single-part epoxies require heat input either by oven, infrared lamp, hot air gun or induction heating. Two-part epoxy cure can also be accelerated by heating bonded parts.

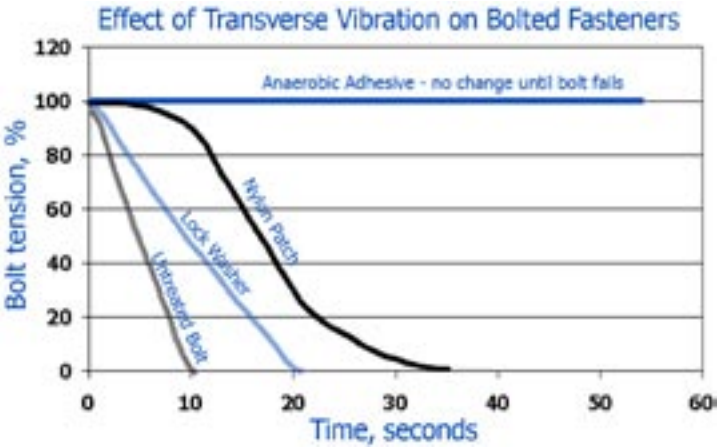
Production Line

Threadlocking

Permabond threadlocking anaerobic adhesives enable you to lock screws, nuts, bolts and studs to protect against loosening caused by vibration.

Benefits

- Prevents nuts rusting on to bolts
- Permabond offer a range of strengths - low strength for parts which may require future disassembly, medium strength and high strength permanent threadlockers to prevent theft and vandalism.
- More cost-effective than using mechanical fastenings
- Lubricates for easier assembly
- Machining tolerances can be increased
- Seals against leaks
- Stops nuts and bolts working loose through vibration



Handy Tip: For blind holes, apply the adhesive directly into the bottom of the hole, not the fastener. If there is a void then apply the adhesive to the thread inside the hole instead.

The "diameter" effect

It is vital to consider the diameter and engagement length of fastenings if there is a future requirement to dismantle them. Doubling the diameter will increase strength six-fold!

Select-a-threadlocker:

Product	Feature	Max. Gap	Strength	Handling Time	Max. °C
LM113	Very easy to undo when necessary.	0.15 mm	Low	10-25 mins	150°C
MM115	Rapid curing. Can be dismantled.	0.12 mm	Medium	5-10 mins	150°C
HM118	Slower cure. Can be dismantled.	0.02 mm	Medium - High	5-15 mins	150°C
HM129	Cuts through surface grime on parts which may not be as clean as they should be!	0.15 mm	High	10-20 mins	150°C
HH131	Resistant to high temperatures	0.3 mm	High	20-40 mins	**230°C**

For larger gaps, please call the Permabond technical help line at 800-640-7599

Other products...

Permabond ASC10 surface activator to speed-up adhesive cure and for use on inactive surfaces.

Choosing a Threadlocker

- If threads are coarse and/or the fastener has a large diameter, select an adhesive with greater gap fill capability.
- Check the service temperature is acceptable.
- Consider if future disassembly is required or if the locking needs to be permanent.
- Check the surface reactivity (in the surface preparation section of this booklet, it may be necessary to activate the surfaces prior to bonding).

Usage Rates

Metric size	Imperial size	Volume of adhesive per fastener	How many components per bottle?	
			50ml	250ml
M3	1/8	0.006ml	8,000	32,000
M6	1/2"	0.018ml	2,500	10,000
M10	3/8"	0.06ml	800	3,200
M20	3/4"	0.46ml	100	400
M30	1 1/8"	1ml	50	200

This is an approximate guide, variables include coarseness of thread, variation in gap, over-application and unusual engagement lengths.

Thread-Locking

Pipesealing

Permabond pipesealing anaerobic adhesives are designed to replace traditional thread sealing materials such as hemp, PTFE tape or pipe dopes.

Benefits

- No loose particles to clog valves
- Will not shred, creep or relax over time
- Easy to apply, allows accurate positioning of pipes and fittings
- Lubricates for easier assembly
- Seals to the burst pressure of the pipe when fully cured
- Suitable for water, gas, air and hydraulic systems
- Resistant to a wide variety of chemicals

Application Techniques

Correct (Parallel to parallel pipe joints):

Apply a bead of adhesive to the leading edge of the male part.

Correct (Taper to parallel pipe joints):

Apply a bead of adhesive several threads back on the male part.

Incorrect (Parallel to parallel pipe joints):

Applying the adhesive to the female pushes it into the pipe. It is impossible to tell if you have enough adhesive as no excess can be seen on the outside of the joint.

Incorrect (Taper to parallel pipe joints):

The adhesive has been applied to the area where least contact is made between the parts, resulting in a poor seal.

Incorrect (Taper to parallel pipe joints):

Again, it is impossible to see if enough adhesive has been used as there is no excess visible.
N.B. Excess adhesive on the inside of a pipe joint can be easily flushed away when the pipework is purged before use.

Select-a-pipesealant:

Product	Feature	Viscosity	Strength	Handling Time	Max. °C	Approvals
LH054	Easy to remove, low strength	260,000	Low	60-140 mins	177	
LH050	General Purpose	250,000	Medium	60-140 mins	177	UL Listed
LH050 Pure	NSF/ANSI certified	250,000	Medium	60-140 mins	177	NSF/ANSI 61
LH150	For stainless steel pipe	260,000	Medium	60-140 mins	177	UL Listed
MH052	Excellent Chemical resistance; approved for use with oxygen	50,000	Medium	10-30 mins	150	BAM

Handy Tip: Pipe joints sealed with low-strength pipe sealants can be dismantled using normal tools. Heating parts with a hot air gun or blow torch will help weaken adhesive and make parts easier to undo. Before re-using, clean pipe joints with a wire brush.

Other products...

Permabond ASC10 surface activator to speed-up adhesive cure and for use on inactive surfaces.

Metric size	Imperial size	Volume of adhesive per fastener	How many pipe-joints per bottle?	
			50ml	250ml
3mm	1/8"	0.07ml	700	3,450
6mm	1/4"	0.1ml	500	2,600
9mm	3/8"	0.12ml	400	2,100
12mm	1/2"	0.14ml	340	1,700
19mm	3/4"	0.193ml	260	1,300
25mm	1"	0.242	200	1,000

Gasketing

Permabond gasketing anaerobic adhesives are designed to replace traditional cork, wood, rubber, paper and silicone gaskets.

Benefits

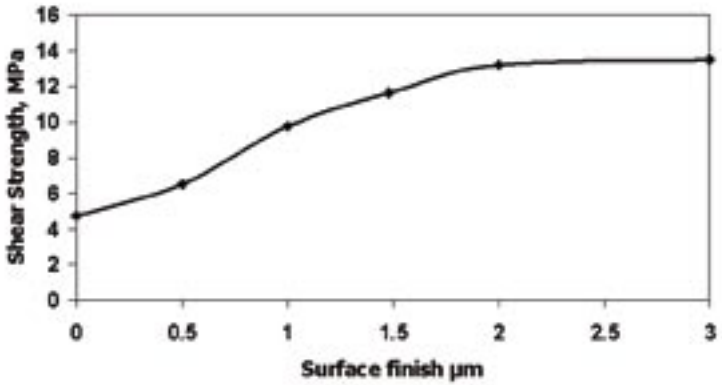
- No relaxation or shrinkage so no need to retighten over time
- One adhesive will replace many pre-cut gasket shapes
- No need to handle fragile gaskets
- No disintegration so no leaks or blockages
- Vibration proof
- No long-term embrittlement
- Easy to dismantle with normal tools
- Less machining - surfaces need not be so smooth
- Non-shimming - (100% metal to metal contact - so better stress distribution)

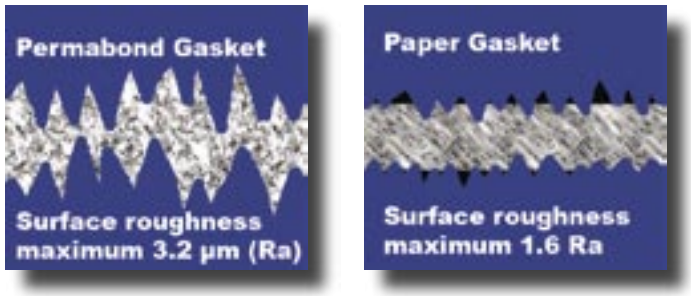
Application Technique

1. Ensure parts are clean, dry and free of any surface contamination, or heavy contamination, use Permabond Cleaner A.
2. Apply adhesive as a continuous bead, taking care to encircle bolt holes fully for an unbroken seal. Methods of application include application directly from the bottle, via roller, silk-screen or stencil.
3. Apply the same gasketing adhesive to the bolt threads for additional leak-protection and vibration resistance.
4. Assemble parts and tighten bolts.

To dismantle parts...
Normal tools can be used, if necessary use a mallet. For routine maintenance and dismantling, or where softer metals could be easily damaged (such as certain aluminium alloys), we recommend Permabond LH197. Before re-applying gasketing adhesive, we recommend lightly abrading and cleaning surfaces.
USE PERMABOND TO REPLACE PRE-CUT GASKETS!

Effect of surface roughness on shear strength of Permabond MH196





Not only do liquid gasketing adhesives give 100% contact between metal parts, but they also allow the engineer to cut down the amount of surface-finish machining, therefore reducing costs and increasing production rate.

Select-a-gasketmaker...

Flexibility

Highly flexible
(For softer metals or easy removal)

Tough and Flexible
(Ideal for dissimilar metals)

Rigid
(For high-temperature resistance)

Product	Feature	Max. Gap	Strength	Handling Time	Max. °C
LH197	Soft and 'rubbery'	0.3 mm	Low	20-40 mins	150°C
HH190	General purpose	0.6mm	Medium	10-20 mins	121°C
MH196	High °C resistance, quick cure	0.5 mm	High	10-20 mins	**200°C**
MH199	High temperature resistance	0.5 mm	Medium	15-30 mins	**200°C**

Other products...

Permabond ASC10 surface activator to speed-up adhesive cure and for use on inactive surfaces.

50ml of adhesive will go how far...?

Bead Diameter	Length of Bead	Glue line thickness (over 25mm width)
1.5mm ●	25m	0.075mm
3mm ⬤	6m	0.3mm

Calculation for volume of a bead of adhesive:

$$\text{Volume (ml)} = \frac{\pi D^2}{4} \times L$$

L = Length of bead in cm
D = Diameter of bead in cm

Gasketing

Retaining

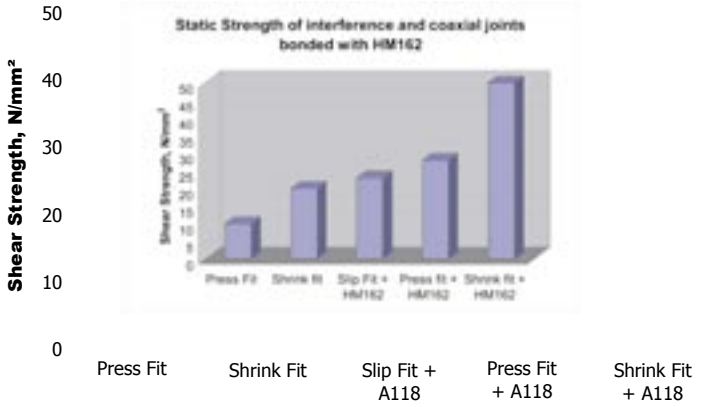
Retaining adhesives are for the permanent bonding of coaxial joints. Typical applications include:

- Bearings into housings
- Bushes
- Keyways and splines
- Gears
- Rotors
- Pulleys
- Cylinder linings
- Flywheels

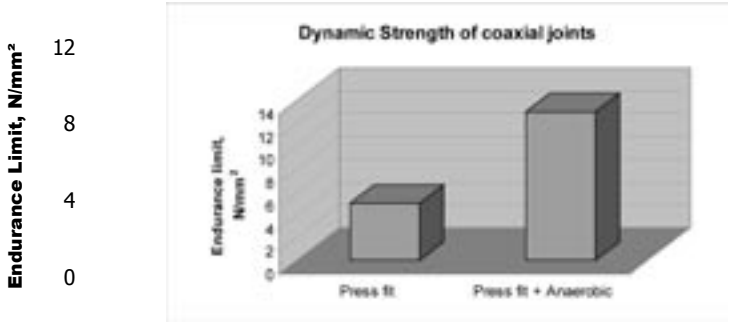
Benefits of using retaining adhesive include rapid, quick and easy assembly of parts. Tolerances can be relaxed, reducing machining times and eliminating the need for interference fits. Adhesive strength is usually higher than alternative methods of fixture. Adhesives have a better fatigue life as they prevent metal fretting (which can be an issue with interference fits).

Anaerobic adhesives have excellent dynamic performance partly due to their ability to fill air space between mating components. This ensures 100% contact between parts and a much improved stress distribution, improving both the static strength and dynamic performance. In contrast, force fits normally result in less than 25% surface contact. The graphs to the right of this page demonstrate these differences in static and dynamic joints.

Graph showing static strength of interference and bonded coaxial joints (with Permabond A118)



Dynamic strength of coaxial joints



Select-a-retainer...

Product	Feature	Viscosity cPs	Shear Strength (psi)	Handling Time (mins)	Max. °C
HL126	Wicking for post assembly application	12	1500	8	150°C
HL138	General Purpose, Press Fit	150	2300	10	150°C
HM160	General Purpose, Slip Fit	600	3000	10	177°C
HM162	Fast cure - High Temp Resistant	800	4300	5	200°C
HM161	Gap fill	2000	3500	10	177°C
HH040	General Purpose, Max Gap Fill	5000	2000	15	150°C
HH040 Pure	General Purpose, NSF/ANSI 61	5000	2000	15	150°C
HM165	Max Gap Fill, High Temp Resistant	10,000	3800	15	230°C
HH167	Max Gap Fill, metal repair paste	500,000	4700	15	150°C

Handling time measured on steel at room temperature.

Other products...

Permabond ASC10 surface activator to speed up adhesive cure and for use on inactive surfaces.

Handy Tip: Apply adhesive to leading edges of both components and assemble with a rotating action.
Take extra care to prevent adhesive entering mechanisms and bearing races!

Bonding Other Materials

Instant Bonding - Permabond Cyanoacrylates

With just one drop of Permabond Cyanoacrylate adhesive, it is possible to bond a wide variety of materials, including metal, plastic, rubber and wood in a matter of seconds. They cure by reacting with minute traces of surface moisture. They are single part so are easy and convenient to use and they cure at room temperature. Permabond Cyanoacrylates cure to a very high strength and have good chemical resistance.

Product	Key Feature
101	Low, penetrating viscosity. Ideal for post-assembly application
102	General purpose, drinking water approved product
105	For hard-to-bond plastics and rubbers
737	Toughened, flexible and has excellent impact resistance
792	General purpose, surface insensitive, rapid curing and very high-strength
820	High temperature resistance up to 200°C
910	Best performance on metals
943	Low odor and non-blooming; excellent aesthetic appearance
2011	High viscosity non-drip gel, ideal for larger gaps or vertical application
POP Primer	For priming polypropylene, polyethylene, silicone and PTFE before bonding with Permabond Cyanoacrylates
QFS16	Surface activator for optional use with Permabond cyanoacrylates (accelerates cure and cures excess adhesive outside joints)

Above is a small selection of the Permabond Cyanoacrylate range.

Handy Tip: 'Less is more' - Cyanoacrylates are very efficient so only small drops are required to obtain a high-strength bond.

Permabond Epoxy Adhesives

Two-part epoxies are well-known for high-performance, versatility and excellent environmental & chemical resistance. Permabond's epoxies have been designed to offer a variety of performance characteristics not normally associated with epoxies - such as additional toughness and high peel strength.

Product	Key Feature
ET500	5-minute cure. Clear for a superb finished appearance
ET505	Toughened, high-peel strength, ideal for structural bonding applications
ET510	Rapid curing version of ET505
ET515	Clear, flexible product with excellent impact resistance and toughness

Two-part epoxies are comprised of resin and hardener, when mixed they cure. Permabond's two-part epoxies listed above are 1:1 mix ratio to make mixing as easy as possible. They cure at room temperature so there is no requirement for heat-cure equipment.

Application examples:

- Structural bonding e.g. metal to GRP
- Marine applications
- Aerospace applications - bonding composites
- Automotive interior applications - plastics and wood (fascias)
- Filter end caps

Handy Tip: Permabond offer a low-cost 50ml dual cartridge adaptor which fits 300ml caulking guns (commonly used for sealants).

Permabond Structural Acrylic Adhesives

These are toughened, high-strength two-part adhesives that cure rapidly at room temperature. They are ideal for bonding a wide variety of materials including metals, plastics, composites, glass and wood. Typical applications include:

- Motor magnet bonding
- Sign bonding (road / shop)
- Metal structures
- Bonding interior trim on trains, buses, cars and aircraft.

Permabond offers two types of structural acrylic adhesives, neither requires mixing.

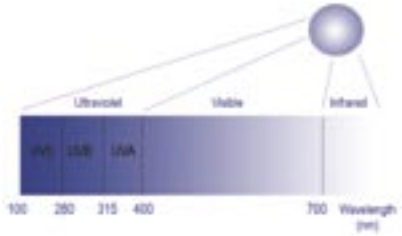
No-mix adhesive & initiator: Initiator is applied to one of the bonding surfaces and the adhesive to the other. Suited to tight fitting parts, this system provides a long open time and a short cure time.

Bead on bead: A bead of Part A is applied directly over a bead of Part B (approximately 1:1 ratio).

Product	Key Feature
TA430	Resin & initiator. Suitable for very high-strength bonding of metals, plastic, ceramics and wood. Cures in 1 - 4 minutes.
TA435	Resin & initiator. Suitable for very high-strength bonding of metals, plastic, ceramics and thermoplastics. Cures in 1 - 4 minutes. Ideal where components could be subjected to thermal cycling.
TA440	Bead on bead. For rapid bonding of metal, ceramic, glass, wood and rigid plastics.

Permabond UV-Curable Adhesives

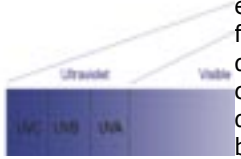
Permabond's UV-curables are suitable for bonding glass, plastic, metal, crystal and ceramic components. They cure almost instantly when exposed to UV-light in the UVA spectrum so one substrate must allow transmittance of UV light through to the adhesive.



Applications include:

- Glass/metal furniture
- Bathroom fittings
- Acrylic bonding
- Decorative crystal items

Product	Key Feature
UV610	For high strength bonding of glass to metal
UV620	General purpose, clear, non-yellowing for a crystal clear finish for glass
UV625	Non-drip gel for bigger gaps / vertical application
UV630	Excellent adhesion to plastics - cures through UV-stabilized plastics
UV640	High viscosity version of UV630
UV670	Ideal for bonding metals and metallized plastics and glass



Permabond UV-curables have unusual elongation characteristics. This allows for better performance when bonding dissimilar substrates in a temperature changing environment where thermal differential expansion and contraction could be an issue.

Permabond has close relationships with several lamp and dispensing equipment manufacturers who can help find a turnkey solution for your production line.

Glossary

Activator (or accelerator) A substance which accelerates the cure rate of adhesive.

Adhesion Failure Failure of the adhesive to the substrate. No adhesive is left on the substrate. Improving surface preparation can help avoid this.

Ageing Adhesives can age from the effects of heat, chemical exposure and humidity. Accelerated ageing tests can be carried out in extreme environments for a quick indication as to the longevity of the adhesive.

Blooming A phenomenon associated with cyanoacrylate adhesives seen as a white powdery residue on substrate material.

Capillary Action Low viscosity adhesives will seep into narrow gaps which makes them suitable for post-assembly application.

Coefficient of Expansion A factor for the length of volume a material expands as temperature is increased. Linear coefficient expansion units commonly used are mm/mm/°C x 10-6. This is an important factor to bear in mind when bonding dissimilar materials in a temperature-changing environment.

Cohesive Failure Failure within the adhesive. On examination of failed parts, adhesive should be visible on both components.

Corona Treatment A method of surface preparation, mainly used for hard-to-bond plastics. High voltage discharge across substrate surfaces produces active electrons, helping raise the surface energy and 'wettability' to allow the material to be bonded.

Cyclic Ageing A harsh method of accelerated ageing, ideal for dissimilar materials. This usually involves heat ageing with cyclic temperatures so the effects of differential thermal expansion and contraction can be assessed.

Density The specific gravity of a material measured in g/cm³. Water is the benchmark at 1.0 (at 4°C).

Passive Surface An unreactive metal surface that is highly resistant to chemical attack. Zinc and chrome are good examples. Use of surface activator, ASC10, helps cure anaerobic adhesives.

Plasma Treatment A method of surface preparation, mainly used for hard-to-bond plastics. It is a mixture of electrons and positive ions in a gas which is passed over the substrate, helping raise the surface energy and 'wettability' to allow the material to be bonded.

Pot life The maximum amount of time adhesive can be used after it has been mixed (in a pot!) before it starts becoming semi-cured and too difficult to apply.

Primer A substance that improves the adhesion of adhesives to components and can help improve environmental resistance.

Refractive Index How much a beam of light alters its angle as it passes through a material. Glass is approximately 1.4 to 1.6.

Relative Humidity How saturated air is with moisture (maximum 100%). Low humidity (usually in cold environments) can affect cyanoacrylate cure.

Rheometry How a material flows, slumps etc.

Room Temperature 23±1°C (as specified by DIN/ISO). Viscosity and strength measurements are taken at this temperature.

Shadow Cure This relates to UV-curable adhesives, UV's that have a single UV- cure mechanism will not cure in areas not reached by UV-light.

Shore Hardness A scale set up to asses the hardness of a material, materials measured on the Shore A scale are soft elastomers, Shore D are tough, harder materials. The test is done with a spring-weighted pin that measures depth of penetration (units are 0-100 Sh, the higher the number, the harder the material.

Substrate Failure Failure of the substrate. This is observed as the adhesive joint remains in tact and the substrate either breaks or the surface of the substrate delaminates.

Differential Thermal Expansion & Contraction This occurs when dissimilar materials are bonded together. They are likely to have different coefficients of expansion. Using a toughened or flexible adhesive can help reduce stress on components.

Elongation How much a material 'stretches', usually measured as a percentage.

Fillet The meniscus of adhesive that can be seen on the outside of a joint. When cured, this can help increase strength and protect joints against chemical and moisture ingress.

Flame Treatment A method of surface preparation, mainly used for hard-to-bond plastics. Briefly exposing surfaces to a flame increases surface electron activity, helping raise the surface energy and 'wettability' to allow the material to be bonded.

Glass Transition Temperature (Tg) The temperature at which a normally rigid, brittle "glass-like" structure changes to a soft, elastic material. This can help determine operating temperature limits.

Handling Time/Speed the time at which adhesive has cured to a sufficient strength to allow unclamping and gentle handling of the part.

Inhibition The presence of a chemical that can cause incomplete cure of adhesive. This could be oxygen preventing full cure of an anaerobic adhesive or chemicals within a substrate which could interfere with adhesive cure.

Modulus of Elasticity Determines the point at which a material becomes deformed under tension.

Open Time The length of time freshly applied adhesive is optimal for bonding (after which strength could be compromised).

Outgassing The release of gaseous molecules from adhesive.

Oxidation This commonly occurs in metals such as aluminium and iron (seen as rust) where surface electrons are stolen. Removal of weak oxide layers prior to bonding is recommended.

Surface Tension / Surface Energy An example of a surface with low surface energy is a freshly polished car bonnet sprayed with water droplets. The water droplets stand proud. This is how hard-to bond-materials such as polypropylene behave. Increasing surface energy makes the surface more 'wettable' and able to be bonded. Adhesives are developed to have as low a surface tension as possible to 'wet-out' on difficult surfaces.

Tensile Strength The strength of an adhesive joint pulled apart in tension.

Thixotropy The flow behavior of an adhesive that causes the viscosity to reduce when stirred, mixed or dispensed but will then thicken upon standing (preventing slump and run-off).

Toughened Adhesives can be rubber toughened to allow better flexibility, higher peel strength and better impact resistance. They are ideal for bonding dissimilar substrates where differential thermal expansion and contraction could be an issue.

Torque Strength Measurement of adhesive strength on threaded nuts and bolts. Breakaway, prevail and maximum strength can be measured to assess the 'lockability' of the adhesive. Units are usually Newton-metres (Nm) or in.lb.

Viscosity Measurement of how much a flowable substance flows. This can be measured with a spindle spinning to measure resistance, on an electronic viscometer or with a 'U' tube measuring time taken for material to flow from A to B.

Wettability / Wetting out If a substrate is 'wettable' it will allow liquid (such as adhesive) to be spread across it without droplets bunching up. If droplets do bunch up then the material could be difficult to bond and surface pretreatment may be required.

Working Time / Strength The time at which a newly bonded joint can be put into operation. The joint will have developed approximately 60% of its final strength so can be subjected to normal loading.

Conversion Tables

Weight

1 kilogram (kg)	= 1000 grams (g)
	= 2.2 pounds (lbs)
1 pound (lb)	= 16 ounces (oz)
	= 453.6 grams (g)
1 ounce (oz)	= 28.35 grams (g)
1 gram (g)	= 1,000 milligrams (mg)

Length

1 metre (m)	= 100 centimeters (cm)
	= 1000 millimeters (mm)
	= 3.28 feet
	= 39.37 inches
1 inch	= 2.54 centimeters (cm)
	= 25.4 millimeters (mm)
	= 1000 mils
1 centimeter (cm)	= 0.39 inches
	= 10 millimeters (mm)
1 millimeter (mm)	= 1,000 microns (µm)
1 mil (thou)	= 40 microns

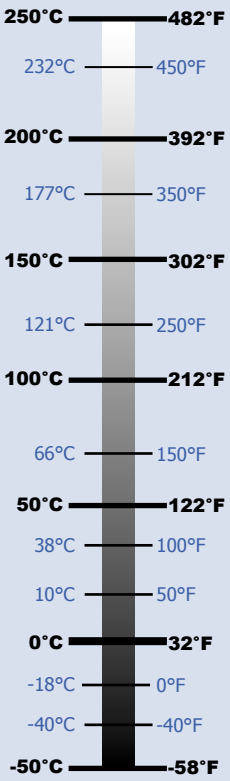
Volume

1 US gallon	= 8 US pints
	= 3.79 liters
	= 4 US quarts
	= 0.83 UK gallons
1 UK gallon	= 8 UK pints
	= 4.55 liters
	= 4 UK quarts
	= 1.2 US gallons
1 liter	= 1000 milliliters (ml)
	= 0.22 UK gallons
	= 0.26 US gallons
	= 1.76 UK pints
	= 2.11 US pints
	= 33.81 fluid ounces
1 US pint	= 473 milliliters (ml)
1 UK pint	= 568 milliliters (ml)
1 milliliter (ml)	= 1 cubic centimeter (cc)
1 cubic inch	= 16.39 cubic centimeters
1 microliter	= 0.001 milliliters

Pressure

1 MPa	=145 psi
1 psi	=0.0069 MPa
1 MPa	=1 N/mm²
1 bar	=14.50 psi
1 psi	=0.069 bar

Temperature



Space for your notes & calculations

Conversion Tables

The information given and the recommendations made in this booklet are based on our experience and are believed to be accurate. No guarantee as to, or responsibility for, their accuracy can be given or accepted, however, and no statement herein is to be treated as a representation or warranty. In every case we urge and recommend that purchasers, before using any product, make their own tests to determine, to their own satisfaction, its suitability for their particular purposes under their own operating conditions.